Active Project (2015 - 2017)

Nonlinear Parameter-Varying AeroServoElastic Reduced Order Model for Aerostructural Sensing and Control Project

SBIR/STTR Programs | Space Technology Mission Directorate (STMD)

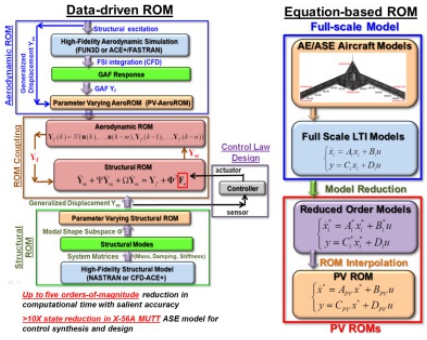
ABSTRACT

The overall goal of the project is to develop reliable reduced order modeling technologies to automatically generate parameter-varying (PV), aeroservoelastic (ASE) reduced-order models (ROMs) for aerostructural sensing and control. In Phase 1, both equation-based and data-driven PV ROM technologies were developed and proof-of-principle was successfully demonstrated. A set of carefully selected ROM algorithms and model coupling schemes were developed in an integrated architecture to generate PV ASE ROMs. Critical evidence was established in NASA relevant case studies that ROMs enable unprecedented speedup and accuracy for aircraft ASE analysis. PV ASE ROMs for X-56A MUTT models in the current mission were developed, which demonstrated >10X reduction in the number of states and precise capture of vehicle dynamics at various flight conditions. In Phase 2, software will be expanded and refined for enhanced performance and functionality. ROM algorithms will be optimized in terms of efficiency for MIMO systems, consistent state representation, PV capabilities in a broad flight envelope. PV structural ROM will also be developed to consider changes in modal parameters at various flight conditions. The strategies for integrating ROMs, sensors and actuators with control design for ASE studies will be tailored to meet various needs in NASA. A modular software environment will be developed with facile interfacing to NASA tools for technology insertion and transition. ROM software will be extensively validated and demonstrated for ASE and flight control analysis of the current X-56A MUTT model, its future release, and other relevant aircrafts.

ANTICIPATED BENEFITS

To NASA funded missions:

Potential NASA Commercial Applications: The proposed technology will provide a fast and accurate analysis tool for ASE simulations of aerospace vehicles and aircrafts. NASA



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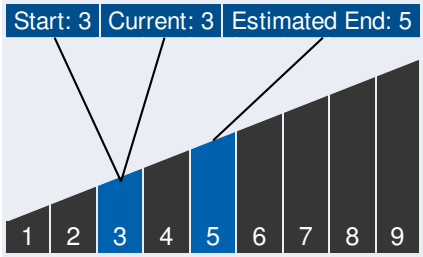
Technology Maturity



Management Team

Program Executive:

- Joseph Grant

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applications of the technology include: (1) rapid and computationally affordable analysis for optimal aerodynamic and structural design of aerospace vehicles; (2) development of advanced, reliable ASE control strategies (such as controlled maneuver, and aeroelastic instability control, e.g., buffet, flutter, buzz, and control reversal); and (3) arrangement of test procedures for rational use of instruments and facilities. The success in the proposed research will markedly reduce the development cycles of aerospace vehicles and aircrafts at reduced costs. NASA programs like aerostructures test wing, active AeroElastic Wing (AEW) and active twist rotors, Multi-Use Technology Testbed (MUTT) will also stand to benefit from the technology.

To the commercial space industry:

Potential Non-NASA Commercial Applications: The non-NASA markets and customers of the proposed software include various aerospace, aircraft, and watercraft engineering sectors (involving fluid-structure-control interaction). Potential end-users and customers include various government agencies such as US Air Force, Missile Defense Agency (MDA), US Army, Space and Missile Defense Command (SMDC), US Navy, etc. In addition, the proposed technology will also find broad markets in industries such as aircraft and aerospace, automobile, combustion, power, propulsion, chemical processing, and micro-electro-mechanical systems (MEMS). The proposed research would directly contribute to these vital areas by providing a powerful tool to generate fast ROMs, which can be extensively used to (1) analyze the operating processes for fault diagnostics and optimized design (e.g., structure and fatigue analysis, real-time flow control and optimization, hardware-in-loop simulation); and (2) develop advanced strategies for on-line process monitoring and control.

Management Team *(cont.)*

Principal Investigator:
- Yi Wang

Technology Areas

Secondary Technology Area:
Modeling, Simulation, Information Technology and Processing (TA 11)
└ Science Modeling (TA 11.2.4)

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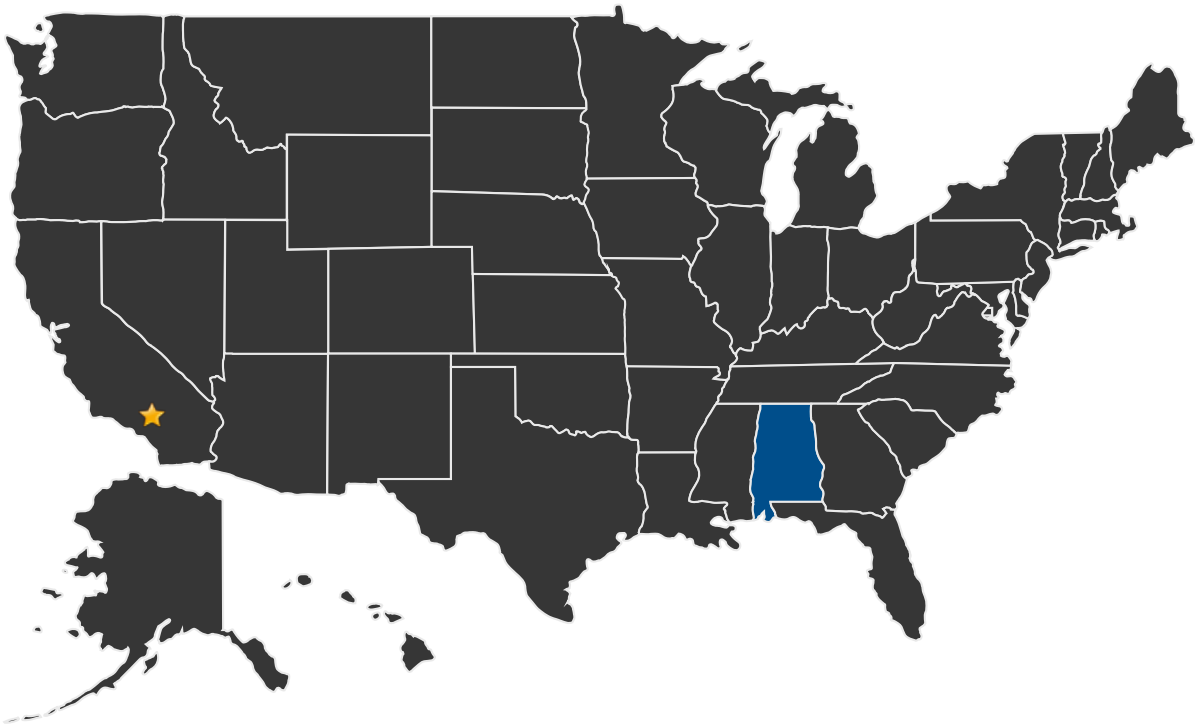
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Armstrong Flight Research Center

Other Organizations Performing Work:

- CFD Research Corporation (Huntsville, AL)

PROJECT LIBRARY

Presentations

- Briefing Chart
  - (http://techport.nasa.gov:80/file/17775)

DETAILS FOR TECHNOLOGY 1

Technology Title

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